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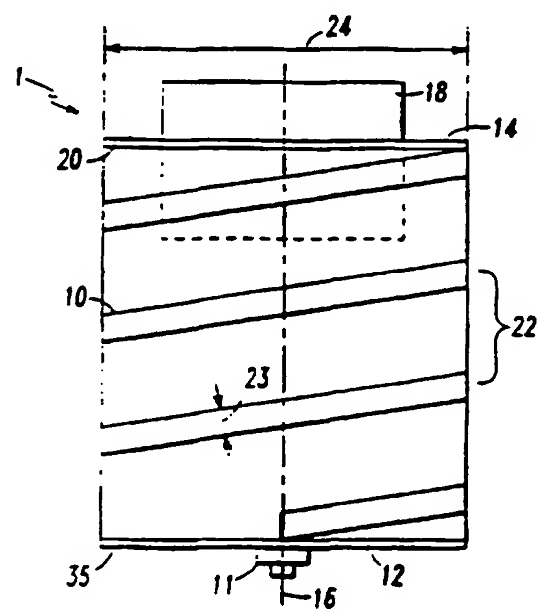
(57) Abstract

An efficiently radiating helical antenna includes a conductive helix receiving signals to be radiated at a first end of the conductive helix device for capacitively pulling fields generated by the signals towards a second end of the conductive helix opposite the first end. The device may be a conductive tube inserted into the second end of the conductive helix or a disjointed conductive helix surrounding the conductive helix. This scheme works especially well for a conductive helix having a circumference on the order of one wavelength.



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HELICAL ANTENNA HAVING A PARASITIC ELEMENT AND A METHOD OF USING THE SAME

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to helical antennas, and, more particularly, to a helical antenna having a parasitic element and a method of using the same. More specifically, the present invention relates to using a parasitic element to lower the impedance at an end of a helical antenna and a method of doing the same.

Description of the Related Art

A helical antenna consists of a single conductor or multiple conductors wound into a helical shape. Although a helix can radiate many modes, the axial mode is the most commonly used mode. The axial mode provides maximum radiation along the helix axis, which occurs when the helix's circumference is on the order of one wavelength of the radiation to be radiated. Radiation radiated from a helical antenna with a circumference of about one wavelength also has quite good circular polarization. The helix forming the helical antenna may be cylindrical, elliptical or conical.

In a wire radiator, any wire that is longer than a quarter of a wavelength is capable of radiating all of the power in it before the power reaches the end of the wire. Therefore, in a helical antenna having a circumference of a wavelength, most of the power is gone before it reaches the end of the winding. This ruins the efficiency of the radiation, which is defined as the ability to radiate along the entire length of the antenna with equal amplitude.

As energy is fed into the feed end of a conductor, the conductor acts as an antenna to radiate the energy from the conductor. The amount of radiation per unit length of the conductor decreases exponentially as the energy is

conducted away from the feed end. In other words, most of the radiation is emitted from the feed end of the antenna while very little is emitted from the opposite end.

Summary of the Invention

Accordingly, a primary object of the present invention is to provide a helical antenna which more efficiently radiates along its entire length.

It is a further object to provide a method for more efficiently radiating along the entire length of the helical antenna.

The objects of the present invention are fulfilled by providing a helical antenna having a conductive helix with a first end and a second end. The first end receives signals to be transmitted. The helical antenna also includes a device for capacitively pulling fields generated by the signals towards the second end.

The device for capacitively pulling the field may be a conductor symmetric about the central axis of the conductive helix. This conductor may be a conductive tube inserted into the second end, and the conductor may be supported in the conductive helix by a dielectric surrounding the conductive tube.

Alternatively, the conductor may surround the conductive helix and may be in the form of a disjointed helix. The segments of the disjointed helix may correspond to the turns of the conductive helix. These disjointed segments are further from the first end of the conductive helix than the corresponding turns of the conductive helix.

The objects of the present invention are also fulfilled by providing a method of efficiently radiating along a helical antenna including the steps of delivering signals to a first end of a conductive helix of a helical antenna, capacitively pulling fields formed by the signals towards a second end of the conductive helix, the second end being opposite the first end, and transmitting the

signals along the conductive helix. The capacitively pulling step may include inserting a conductor into the second end of the conductive helix or surrounding the conductive helix with a conductor.

These and other objects of the present invention will become more readily apparent from the detailed description given hereinafter. However, it should be understood that the detailed descriptions or specific examples all indicating preferred embodiments of the present invention, were given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

Brief Description of the Drawings

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention and wherein:

Figs. 1 and illustrate a side view of a helical antenna of the present invention; and

Fig. 2 is a side view of a second embodiment of the helical antenna of the present invention.

Description of the Preferred Embodiments

Figs. 1 and 2 illustrate a side view of a helical antenna 1 of the present invention. A conductive helix 10 having a first end 12 and a second end 14 radiates energy emanating from the first end 12 along its length. Energy to be radiated is input to the conductive helix 10 with a conventional input connector 11 into a conductive ground plane 35 at the first end 12. The conductive helix 10 has a central axis 16. The helical antenna 1 has a uniform diameter D indicated at 24. The circumference of the helix is equal to πD. The conductor itself has a diameter d indicated at 23. A spacing between the turns of the

conductive helix 10 is indicated at 22. The axial length of the helix is equal to the product of the number of turns and the spacing S. The length of one turn of the helical conductor 10 is equal to the square root of the sum of the circumference squared and the spacing squared.

A first preferred embodiment of the helical antenna 1 of the present invention is shown in Fig. 1. A parasitic conductor 18 is inserted in the second end 14 of the helical conductor 10. The parasitic conductor 18 may be supported by a dielectric material 20 surrounding the parasitic conductor 18 in the second end 14. Thus, the conductive helix 10 has a lower impedance at the second end 14, and hence, more current is delivered, i.e., capacitively pulled, towards the second end 14. The conductor 18 so inserted in the helical conductor 10 forms a floating capacitor. In order for this capacitance to be distributed uniformly, the parasitic conductor 18 should be symmetric about the central axis of 16 of the conductive helix 10. The parasitic conductor 18 may be in the form of a hollow tube.

A second preferred embodiment of the helical antenna 1 is shown in Fig. 2. Here, the conductive helix 10 is surrounded by a parasitic conductive helix 30. The parasitic conductive helix 30 is advantageously not a continuous helix, but rather is disjointed. If the parasitic conductive helix 30 is continuous, since its circumference is clearly larger than that of the conductive helix 10, it might detune and degrade circularity of the radiated output from the conductive helix 10. Disjointed segments of the parasitic conductive helix 30 are labeled 30a, 30b, 30c and 30d. The disjointed segments 30a-30d follow the pattern or pitch of the conductive helix 10.

Each disjointed segment as shown in the side view of Fig. 2 has a corresponding turn 10a, 10b, 10c or 10d in the conductive helix 10. The disjointed segments 30a, 30b, 30c and 30d are separated from their corresponding conductive helix portions 10a, 10b, 10c or 10d by an interhelix

spacing 34. The interhelix spacing 34 is the square root of the sum of the squares of the vertical and horizontal distances between corresponding portions of the conductive helix 10 and the parasitic helix 30. The disjointed segments of the parasitic helix 30 are located above, i.e., further away from, the first end 12 than their corresponding portions 10a, 10b, 10c and 10d of the conductive helix 10. Thus, the field along the conductive helix 10 is capacitively pulled away from the first end 12 as the parasitic conductive helix 30 redistributes the currents of the conductive helix 10.

While the embodiment shown in Fig. 2 does require more space than the embodiment shown in Fig. 1, the larger diameter parasitic helix increases the aperture of the helical antenna 1.

The embodiments disclosed herein are most effective for antennas having a circumference of about one wavelength of the signal to be radiated. For such antennas, there can be as much as a 2 decibel improvement in peak gain. Advantageously, the floating capacitor shown in Fig. 1 is inserted into the conductive helix 10 up from the ground plane 35 by a distance of about a half of a wavelength up from the ground plane 35 of the signal to be radiated and has a diameter of roughly 70% that of the conductive helix. As an example, conductive helix 10 may have a diameter of 2.7" (6.86 cm), a height of 3.5" (8.89 cm), a conductor diameter of .25" (.64 cm), a spacing of 1" (2.54 cm) and 3.25 turns. Advantageously, the interhelix distance 34 in Fig. 2 is an eighth of a wavelength of the signal to be radiated and the conductive helix 10 has a diameter and height roughly 70% that of the parasitic conductive helix 30.

The capacitor shown in either Fig. 1 or Fig. 2 may be formed using any conductor and dielectric. The exact parameters to be used are determined empirically for each conductive helix seeking to optimize gain and circularity. Preferably, the parasitic element will provide an increase

in capacitance at the second end, such that the exponential current decrease is mitigated or eliminated.

The invention being thus described, it would be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

What is claimed is:

1. A helical antenna comprising:

a conductive helix having a first end and a second end, said first end having an input for accepting signals to be transmitted; and

means for capacitively pulling a field generated by said signals input to said conductive helix towards said second end.

2. The helical antenna as claimed in claim 1, wherein said capacitively pulling means comprises a conductor symmetric about a central axis of said conductive helix.

3. The helical antenna as claimed in claim 2, wherein said conductor comprises a conductive tube inserted into said second end.

4. The helical antenna as claimed in claim 3, wherein said conductive tube is supported in said helical conductor by a dielectric surrounding said conductive tube.

5. The helical antenna as claimed in claim 3, said helical antenna further comprising a conductive ground plane at said first end and wherein said conductive tube is inserted in said second end up from said conductive ground plane by a distance of half of a wavelength of said signals.

6. The helical antenna as claimed in claim 1, wherein said capacitively pulling means comprises a conductor disposed around a central axis of said conductive helix and surrounding said conductive helix.

7. The helical antenna as claimed in claim 6, wherein said conductor comprises a disjointed helix.

8. The helical antenna as claimed in claim 7, wherein said disjointed helix comprises disjointed segments which follow the turn of said conductive helix.

9. The helical antenna as claimed in claim 8, wherein each turn of said conductive helix has a

corresponding segment in said disjointed helix located further from said first end than a corresponding turn.

10. The helical antenna as claimed in claim 9, wherein each turn and said corresponding segment are separated by a distance of approximately an eighth of a wavelength of said signals.

11. The helical antenna as claimed in claim 1, wherein said conductive helix has a circumference of approximately one wavelength of said signals.

12. A method of efficiently radiating along a helical antenna comprising the steps of:

delivering signals to a first end of a conductive helix of said helical antenna;

capacitively pulling a field generated by said signals towards a second end of said conductive helix, said second end being opposite said first end; and

transmitting said signals along said conductive helix.

13. The method as claimed in claim 12, wherein said capacitively pulling step comprises inserting a conductor into said second end of said conductive helix.

14. The method as claimed in claim 13, wherein said capacitively pulling step further comprises mounting said conductor in said second end using a dielectric surrounding said conductor.

15. The method as claimed in claim 12, wherein said capacitively pulling step comprises surrounding said conductive helix with a disjointed helical conductor.

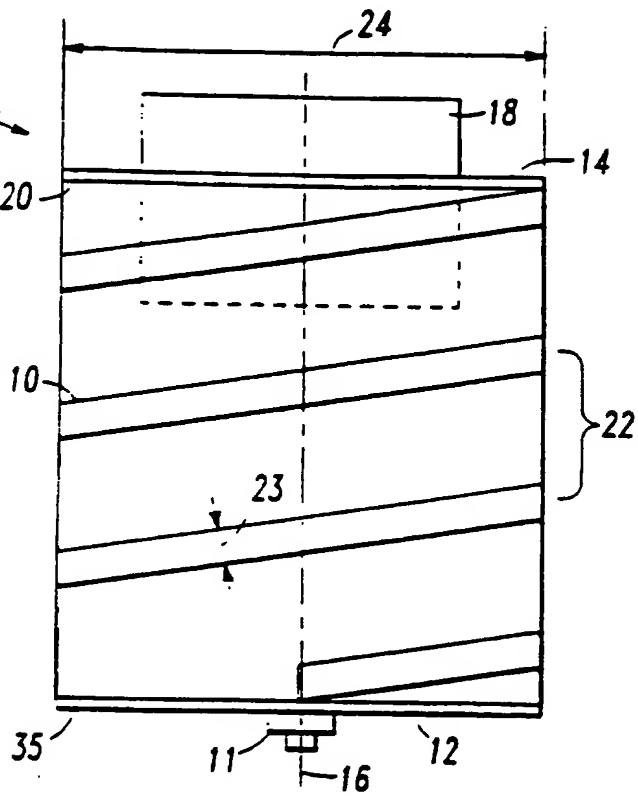
24
1
18
14
20
10
22
23
35
11
16
12

FIG. 1

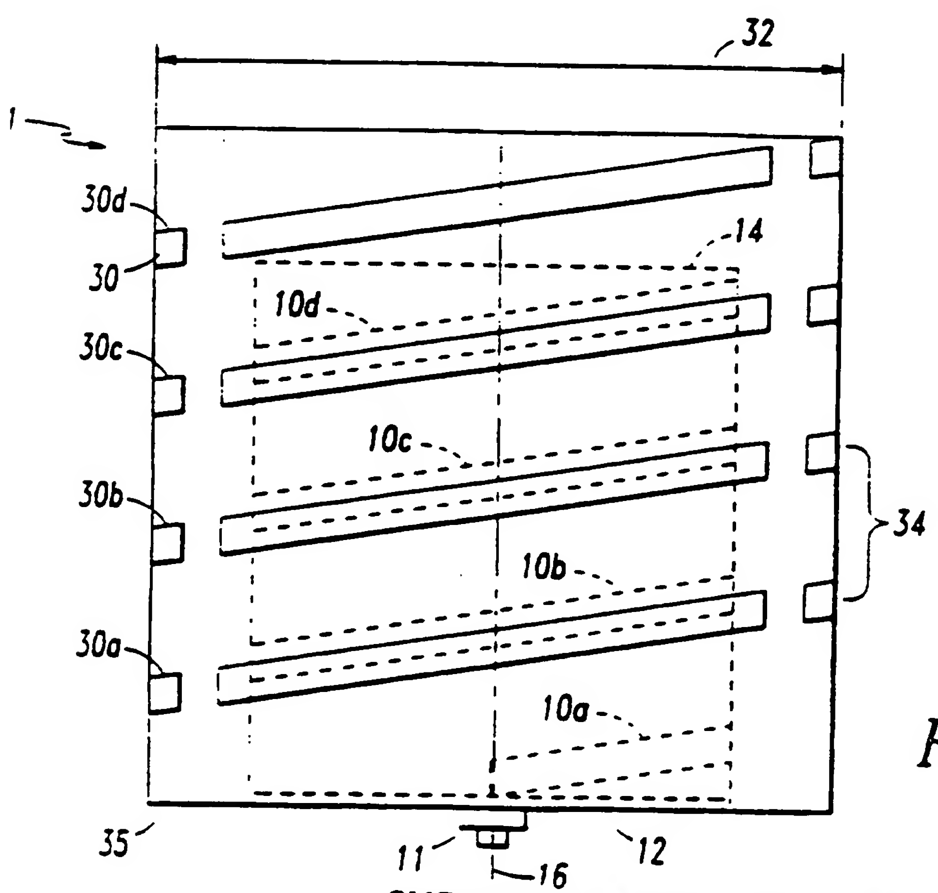
32
1
30d
30
14
10d
30c
10c
30b
34
10b
30a
10a
35
11
16
12

FIG. 2

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 95/11842

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01Q11/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 17 no. 518 (E-1434) ,17 September 1993 & JP,A,05 136623 (SANSEI DENKI) 1 June 1993, see abstract ---	1-4, 12-14
X	PATENT ABSTRACTS OF JAPAN vol. 16 no. 22 (E-1156) ,20 January 1992 & JP,A,03 236612 (NOZOMI HASEBE) 22 October 1991, see abstract ---	1,6,12
X	US,A,4 161 737 (ALBRIGHT) 17 July 1979 see abstract; claims 1-8; figure 4 ---	1,6,12
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[X] Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, vol. 16, no. 4, July 1968 NEW YORK US, pages 491-493, ADAMS 'Helix Modes 1 and 2 of Klock' see the whole document ---	1-15
A	IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, vol. 38, no. 4, April 1990 NEW YORK US, pages 578-584, XP 000135730 PETERSON ET AL. 'Propagation and Radiation Characteristics of the Tape Helix with a Conducting Core and Dielectric Substrate ' see page 578; figure 1 ---	1-15
A	IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, vol. 34, no. 9, September 1986 NEW YORK US, pages 1143-1148, NAKANO ET AL. 'Axial Mode Helical Antennas' see page 1145 - page 1147; figures 4-8 -----	1-15

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-4161737	17-07-79	NONE	